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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/658,114

09/08/2003

Renat Bilyalov

IMEC285.001AUS

9690

20995 7590 12/26/2006
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EXAMINER

TRINH, THANH TRUC

ART UNIT

PAPER NUMBER

1753

SHORTENED STATUTORY PERIOD OF RESPONSE	NOTIFICATION DATE	DELIVERY MODE
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3 MONTHS

12/26/2006

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Notice of this Office communication was sent electronically on the above-indicated "Notification Date" and has a shortened statutory period for reply of 3 MONTHS from 12/26/2006.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 10/658,114	Applicant(s) BILYALOV ET AL.	
	Examiner Thanh-Truc Trinh	Art Unit 1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 September 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-36 is/are pending in the application.
- 4a) Of the above claim(s) 27-36 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-26 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date <u>02/11/04</u> . | 6) <input type="checkbox"/> Other: _____ |

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DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C.

121:

- I. Claims 1-26, drawn to a product, classified in class 136, subclass 243.
- II. Claim 27-36, drawn to a method, classified in class 438, subclass 48.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process of making and product made.

The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by different methods such as electroplating.

Because these inventions are independent or distinct for the reasons given above and there would be a serious burden on the examiner if restriction is not required because the inventions require a different field of search (see MPEP § 808.02), restriction for examination purposes as indicated is proper.

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During a telephone conversation with the Applicant's representative, Rose M. Thiessen, on 11/14/06 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-26. Affirmation of this election must be made by applicant in replying to this Office action. Invention of Group II is withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Application is advised that the reply to this requirement to be complete must include an election of the invention to be examined even though the requirement be traversed (37 CFR 1.143).

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claim 1, 3-23 and 26 are rejected under 35 U.S.C. 102(e) as being anticipated by Stalmans et al. (US Patent 6683367).

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Regarding claim 1, Stalmans et al disclose a photovoltaic device comprising a first layer, or non-porous layer 3 or 15, having a first semiconductor material of first conductivity type in one region (See col. 3 lines 1-9 or claim 1); a second layer, or substrate 1 or 13, having a second semiconductor material of a second conductivity type (See col. 4 lines 17-19, claim 20), wherein the second conductivity type is opposite the first conductivity type; a third layer (porous Si 2 or 14) having a third semiconductor material and situating between the first layer and the second layer. The third layer is porous, translucent, and a diffusion barrier. (See Figure 7, 9, and col. 2 lines 32-47)

Regarding claim 3, Stalmans et al describe the photovoltaic device is a solar cell (See claim 22).

Regarding claims 4-7, Stalmans et al teach that the first, second and third semiconductor material comprise silicon. In other words, they all comprise a same semiconductor material and element. (See claims 2, 4 and 20)

Regarding claims 8-10, Stalmans et al teach that the second and third semiconductor materials comprise silicon. (See claims 20, 2).

Regarding claims 11-13, Stalmans et al teach that the first and third semiconductor materials comprise silicon. (See claims 4, 2).

Regarding claims 14-16, Stalmans et al teach that the first and the second semiconductor material comprise silicon. (See claims 4, 20).

Regarding claims 17-19, Stalmans et al describe that the porous layer is etched from silicon wafer. (See col. 7 lines 63-67). Therefore, the porous layer comprises silicon which is inherently non-doped. In addition, silicon wafer is generally crystalline, either monocrystalline or multicrystalline.

Regarding claims 20-21, Stalmans et al describe the second layer (or the substrate) can be a silicon wafer. (See col. 7 lines 63-67). In addition, silicon wafer is either monocrystalline or multicrystalline semiconductor material.

Regarding claim 22, Stalmans et al describe the first layer comprises a thickness of from about 0.1 μm to 10 μm (See claim 9). This first layer or non-porous layer further divides into two sub-layers, therefore the thickness of the sub-layer with opposite conductivity to the second layer (or the substrate) is inherently in the range of less than 0.1 μm to less than 10 μm . A thickness of less than 0.1 μm is well within the claimed range of about 3nm to about 100nm.

Note: 0.1 μm = 100 nm.

Regarding claim 23, Stalmans et al disclose a dielectric layer of silicon nitride in place of non-porous layer, or first layer, on porous silicon layer. (See col. 10 lines 46-49 and claim 16). In other words, the photovoltaic device as

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described in claim 1 further comprises an amorphous silicon layer situating between the first and the third layer.

Regarding claim 26, Stalmans et al teach that the substrate (or second layer) is etched to form porous layers within the substrate (See col. 8 lines 25-33). The porosity changes gradually from bottom to top. (See col. 3 lines 10-14 or col. 10 lines 63-67 and col. 11 lines 1-4 or claim 6, 12-13)

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

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4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claims 2, 24-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Stalmans et al in view of Fathauer et al (US Patent 5757024).

Regarding claim 2, Stalmans et al disclose a photovoltaic device as described in claim 1.

Stalmans et al do not explicitly teach that the thickness of the porous semiconductor layer is from about 1nm to about 50 nm.

Fathauer et al teach that the thickness of porous silicon is in the range of 5 to 20 nm. This would eliminate detrimental porosification in the non-porous silicon layers. (See col. 3 lines 23-28).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Stalmans et al by having the thickness of porous layer of about 5 nm to about 20 nm as taught by Fathauer et al, because it would eliminate detrimental porosification (See col. 3 lines 24-26).

Regarding claims 24-25, Stalmans et al disclose a photovoltaic device as described in claim 1.

Stalmans et al do not teach about the fourth layer of porous semiconductor material attaching to the second layer (or the substrate).

Stalmans et al also do not teach that there is a fifth layer of semiconductor material comprising the same conductivity type with the fourth layer and

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attaching to the fourth layer, wherein the fifth layer comprises a material selected from the group consisting of amorphous silicon, nanocrystalline, and microcrystalline semiconductor.

Fathauer et al teach multiple alternating layers of monocrystalline semiconductor with a thickness in nanometer (See col. 3 lines 50-54) and thin porous Si-Ge. These layers have silicon as their primary semiconductor material. Without doping material, they are inherently having the same conductivity type. (See abstract or col. 6 lines 56-67 and col. 7 lines 1-18 and Figures 1-2)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Stalmans et al by forming multiple alternating layers of silicon and porous silicon-containing, because it would increase the efficiency and the use of the device. (See col. 9 lines 37-49)

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claim 1, 3, 4-23 are rejected under 35 U.S.C. 102(b) as being anticipated by Yamada et al. (US Patent 5331180).

Regarding claim 1, Yamada et al disclose a photovoltaic device (See Figure 4) comprising a first layer of first semiconductor material of first conductivity type 42; second layer of second semiconductor material of a second conductivity type 12, wherein the second conductivity type is opposite to the first conductivity type; and a third layer 22 situating between the first and the second layers, wherein the third layer is porous, translucent (See col. 8 lines 36-47, 66-68) and behaves like a diffusion barrier. (See abstract)

Regarding claim 3, Yamada et al describe the photovoltaic device is a photodiode (See col. 3 lines 12-14 or claim 1).

Regarding claims 4-7, Yamada et al teach that the first, second and third semiconductor material comprise silicon. In other words, they all comprise a same semiconductor material and element. (See col. 8 lines 36-47, 66-68)

Regarding claims 8-10, Yamada et al teach that the second and third semiconductor materials comprise silicon. (See col. 8 lines 36-47).

Regarding claims 11-13, Yamada et al teach that the first and third semiconductor materials comprise silicon. (See col. 8 lines 36-47, 66-68).

Regarding claims 14-16, Yamada et al teach that the first and the second semiconductor material comprise silicon. (See col. 8 lines 36-47, 66-68).

Regarding claims 17-19, Yamada et al describe that the porous layer is etched from polycrystalline silicon. (See col. 8 lines 43-47). Therefore, the porous layer comprises crystalline silicon, and the silicon itself is inherently non-doped.

Regarding claims 20-21, Yamada et al describe the second layer 12 is a polycrystalline Si layer. (See col. 8 lines 39-47).

Regarding claim 22, Yamada et al describe the first layer 42 having thickness of 500 angstroms or 50 nm (See col. 8 lines 66-68), which is well within the claimed range of 3nm to 100 nm.

Regarding claim 23, Yamada et al disclose an amorphous SiO₂ layer 32 on top of porous layer 22 and below the semiconductor layer 42, or between the first and third layers. (See Figure 42 and col. 8 lines 47-51)

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

11. Claims 2, 24-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada et al in view of Fathauer et al (US Patent 5757024).

Regarding claim 2, Yamada et al disclose a photovoltaic device as described in claim 1.

Yamada et al do not explicitly teach that the thickness of the porous semiconductor layer is from about 1nm to about 50 nm.

Fathauer et al teach that the thickness of porous silicon is in the range of 5 to 20 nm. Limiting the thickness of porous layer would eliminate detrimental porosification in adjacent silicon layers (See col. 3 lines 23-28).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Yamada et al by having the

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thickness of porous layer of about 5 nm to about 20 nm as taught by Fathauer et al, because it would eliminate detrimental porosification. (See col. 3 lines 25-27)

Regarding claims 24-25, Yamada et al disclose a photovoltaic device as described in claim 1.

Yamada et al do not teach about the fourth layer of porous semiconductor material attaching to the second layer (or the substrate). Yamada et al also do not teach that there is a fifth layer of semiconductor material comprising the same conductivity type with the fourth layer and attaching to the fourth layer.

Fathauer et al teach multiple alternating layers of monocrystalline semiconductor with a thickness in nanometer (See col. 3 lines 50-54) and thin porous semiconductor. These layers have silicon as their primary semiconductor material. Without doping, these layers inherently have the same conductivity type. (See abstract or col. 6 lines 56-67 and col. 7 lines 1-18 and Figures 1-2)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Yamada et al by forming multiple alternating layers of silicon and porous silicon-containing, because it would increase the efficiency and the use of the device. (See col. 9 lines 37-49)

12. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada et al in view of Stalmans et al.

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Yamada et al disclose a photovoltaic device as described in claim 1 with a porous semiconductor sandwiching between two semiconductor layers with different conductivity types.

Yamada et al do not teach forming plurality of macro etch pits with diameter changing from greater than 1 micron to less than 1 micron.

Stalmans et al teach that the substrate (or second layer) is etched to form porous layers within the substrate (See col. 8 lines 25-33). The porosity changes gradually from bottom to top. (See col. 3 lines 10-14 or col. 10 lines 63-67 and col. 11 lines 1-4 or claims 6, 12-13)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Yamada et al by etching pits with different sizes as taught by Stalmans et al, because beside allowing high-quality epitaxial semiconductor growing, it would also exhibit sufficient strong light diffusion and reflecting. (See col. 11 lines 1-4)

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: US Patent 5272355.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh-Truc Trinh whose telephone number is 571-272-6594. The examiner can normally be reached on 8:30 am - 5:00 pm.

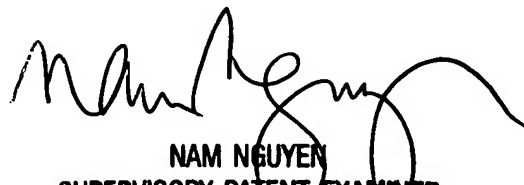
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 571-272-1342. The fax

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phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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12/14/06



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